

第 1581 回 天文学教室談話会

2016 年 2 月 16 日 (火) 16:30 より

東京大学理学部 1 号館西棟 11 階 1109 号室 (天文学専攻会議室) にて

“Rotation curve of M33 explained by dark matter disc”

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We developed a numerical method to compute the gravitational field of an infinitely-thin axisymmetric disc with an arbitrary profile of the surface mass density. We evaluate the gravitational potential by a split quadrature using the double exponential rule and obtain the acceleration vector by numerically differentiating the potential by Ridder’s algorithm. The new method is of around 12 digit accuracy and sufficiently fast because requiring only one-dimensional integration. By using the new method, we show the rotation curve of some non-trivial discs: (i) truncated power-law discs, (ii) discs with a non-negligible center hole, (iii) truncated Mestel discs with edge-softening, (iv) double power-law discs, (v) exponentially-damped power-law discs, and (vi) an exponential disc with a sinusoidal modulation of the density profile. Also, we present a couple of model fittings to the observed rotation curve of M33: (i) the standard deconvolution by assuming a spherical distribution of the dark matter and (ii) a direct fit of infinitely-thin disc mass with a double power-law distribution of the surface mass density. Although the number of free parameters is a little larger, the latter model provides a significantly better fit. The determined profile of the surface mass density of the disc is significantly larger than those of the observed stars and gas. This hints a disc-like distribution of the dark matter.